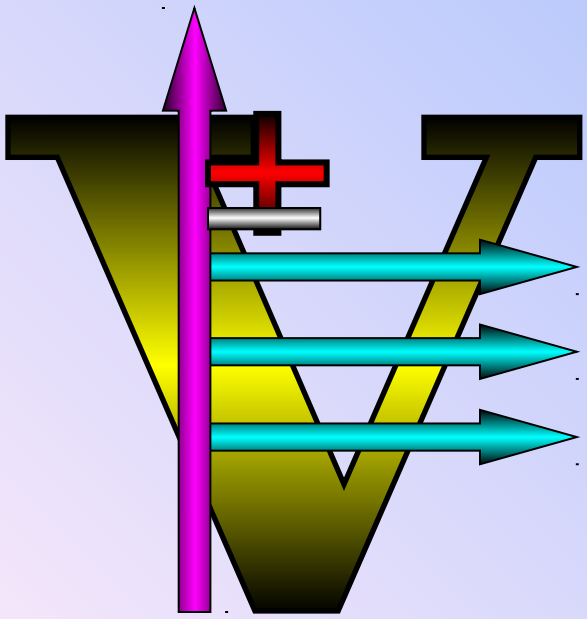
# Voltage Dividers

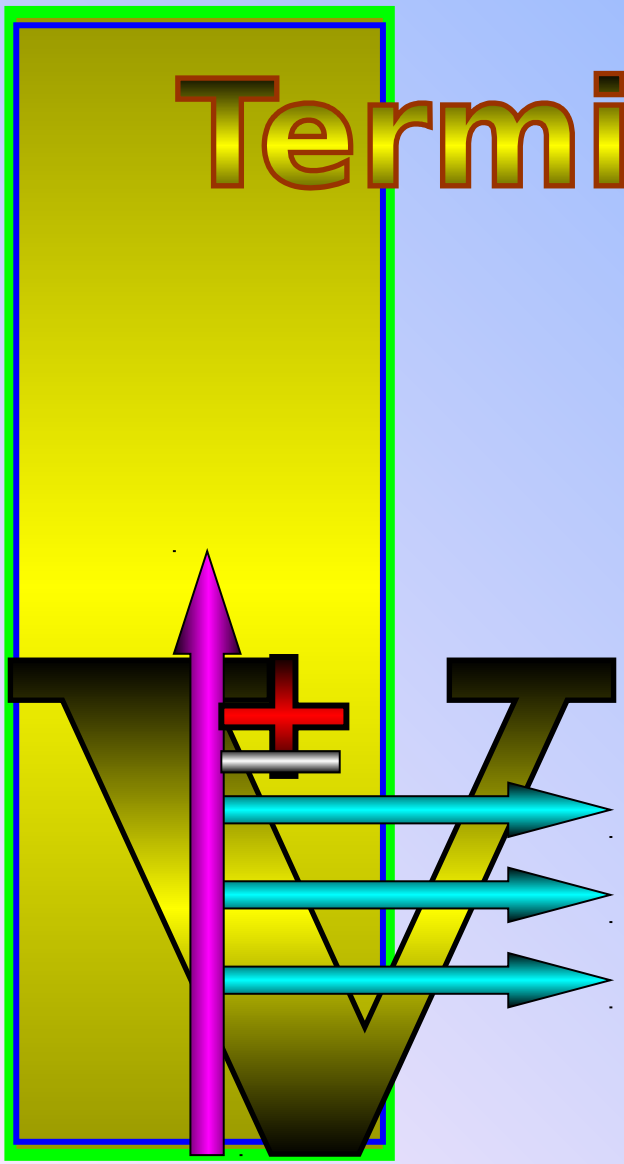


**Unclassified:**

**4 Hour Conference, W/2Hr. PE1**

**Safety & Environmental Impact: “LOW”**

# DC: Voltage Divider



## Terminal Objective

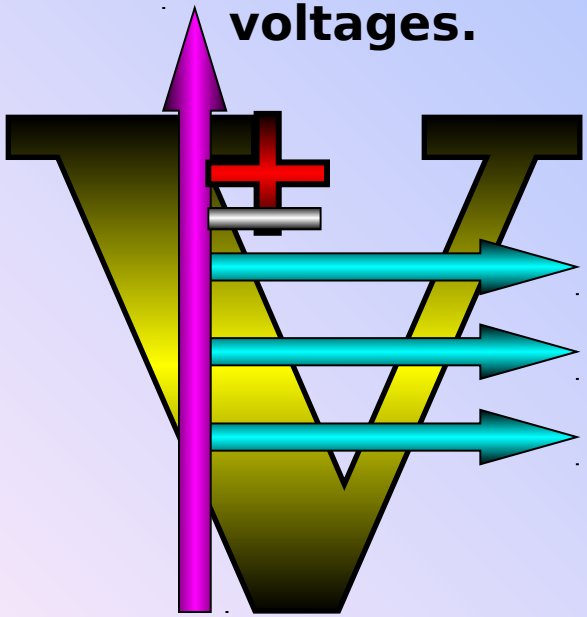
**ACTION:** Calculate the DC voltage, DC current, and resistance in a voltage divider circuit.

**CONDITIONS:** Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130A electronics trainer, digital Multimeter w/test leads, PC-130-56B circuit card, jumper wire, schematic diagram, calculator and official OMEMS references.

**STANDARDS:** Be able to identify positive, negative, and dual polarity voltage divider circuit characteristics, identify the two types of variable resistors used in voltage divider circuits, calculate voltage, current, and resistance values in a voltage divider, properly measure voltage, current, and resistance in a voltage divider, and compare to calculated values to the established standard of 7 correct answers out of 10 & 8 out of 10 for EOD.

# Introduction

**Modern conveniences & defense electronics use forms of electrical Ckts & automation that require many different voltages, both positive & negative at different values. Rather than having a power source for each and every voltage required, a voltage divider can conveniently provide the various voltages.**



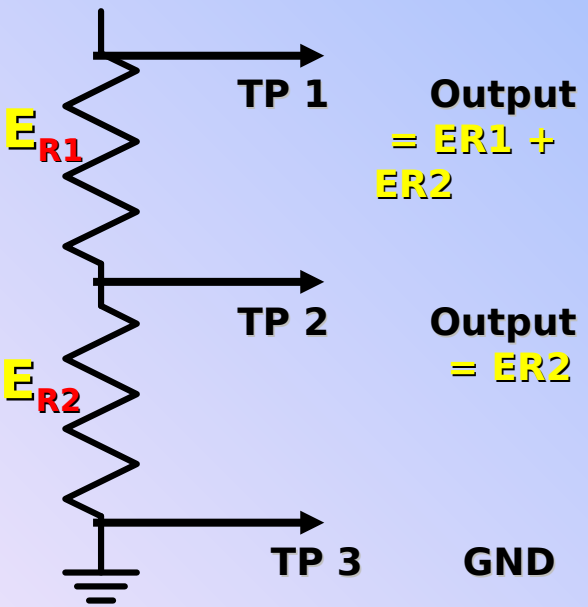
Concep
t

# DC: Voltage Divider

A convenient way to look @ a voltage Divider is to look at it as a simple series Ckt.

All operating parameters are calculated the same, all rules that apply to a series Ckt are still valid.

Emphasis is placed on the voltage at Test Points, also referred to as Output Voltages.




**ALL voltages are taken in reference to GROUND.**

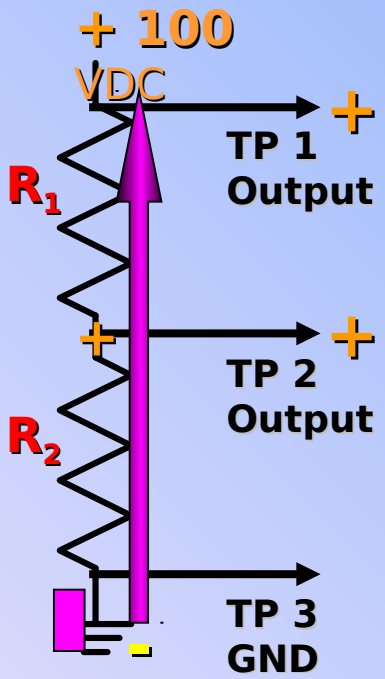
**The Black lead is placed at Gnd.**

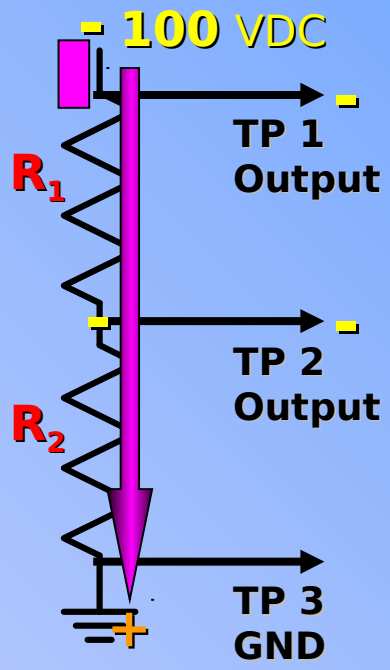
**The Voltage Drops between the leads are those being measured.**

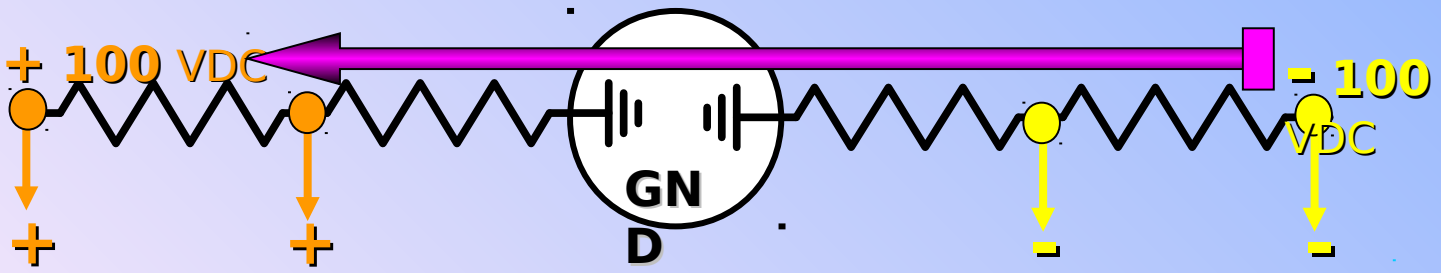
+ & - Voltages

# DC: Voltage Divider

**Voltage Dividers can have A Positive or Negative output, the Point of reference is the Gnd.**




**ALL voltages are taken in reference to GROUND. Ground is the common point of reference.**

+ & - Voltages

# DC: Voltage Divider

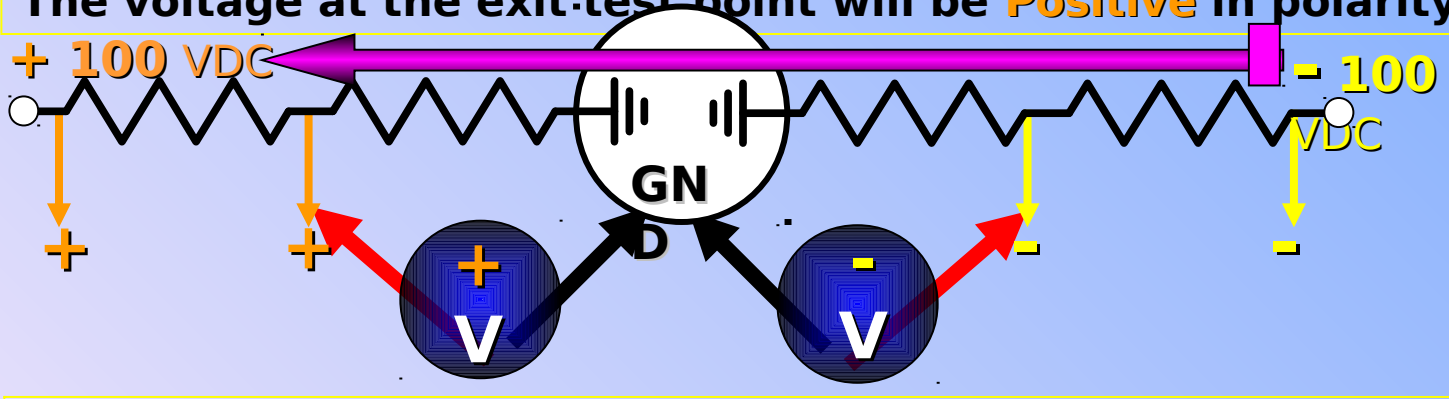
Current flows from the most Negative point in the Ckt to the most Positive point.

Current enters a resistor Negative & leaves more Positive.

The difference of polarity [ potential ] is measurable in respect to the point of entry or exit in reference to Ground.

The voltage at the entry test point will be Negative in polarity.

The voltage at the exit test point will be Positive in polarity.




**Memory Aid:**

If current hits the Red lead before the Black lead, the voltage will be Negative.

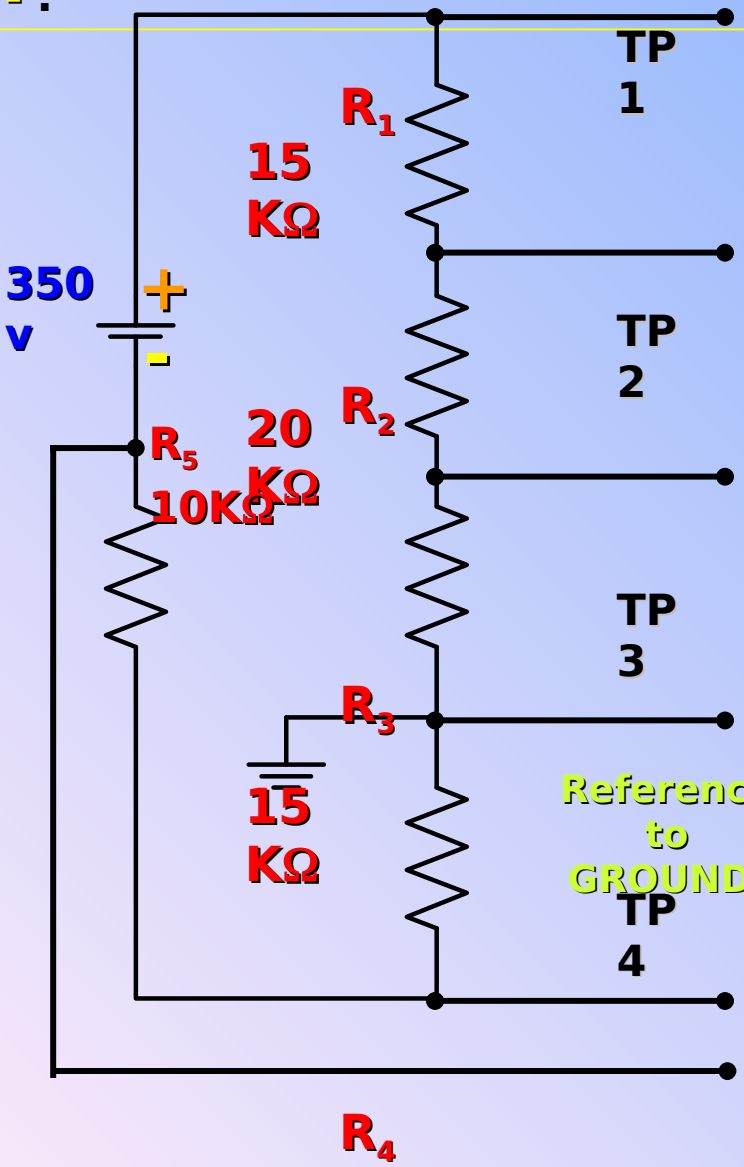
If current hits the Black lead before the Red lead, the voltage will be Positive.

ALL voltages are taken in reference to GROUND.

Challenge

# DC: Voltage Divider

Calculate operating parameters: Show TP Voltage & Polarity, + or - .




$E_A$ = ____

$R_T$ = ____

$I_T$ = ____

$E_{R1}$ = ____

$E_{R2}$ = ____

$E_{R3}$ = ____

$E_{R4}$ = ____

$E_{R5}$ = ____

$E_{TP1}$ = ____

$E_{TP2}$ = ____

$E_{TP3}$ = ____

$E_{TP4}$ = ____

$E_{TP5}$ = ____

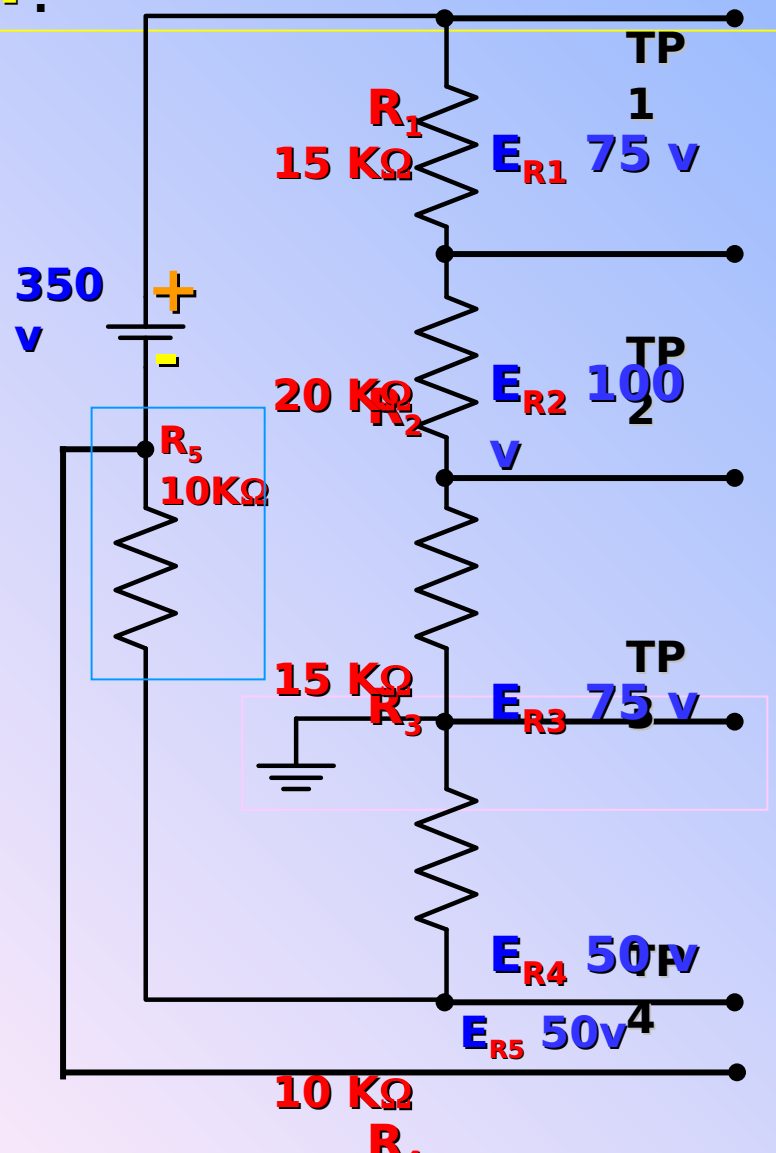
$E_{TP6}$ = ____

**Note: The Voltage @ TP is the SUM of The Voltage Drops From Gnd To the TP being measured, or the Sum of the Voltage Drops between the leads.**

Answers

# DC: Voltage Divider

**Calculate operating parameters: Show TP Voltage & Polarity, + or - .**




EA = 350 v

RT = 70 KΩ

IT = 5 mA

$E_{R1}$ = 75 v

$E_{R2}$ = 100 v

$E_{R3}$ = 75 v

$E_{R4}$ = 50 v

$E_{R5}$ = 50 v

$E_{TP1}$ = 250 v

$E_{TP2}$ = 175 v

$E_{TP3}$ = 75 v

$E_{TP4}$ = 0 v

$E_{TP5}$ = - 50 v

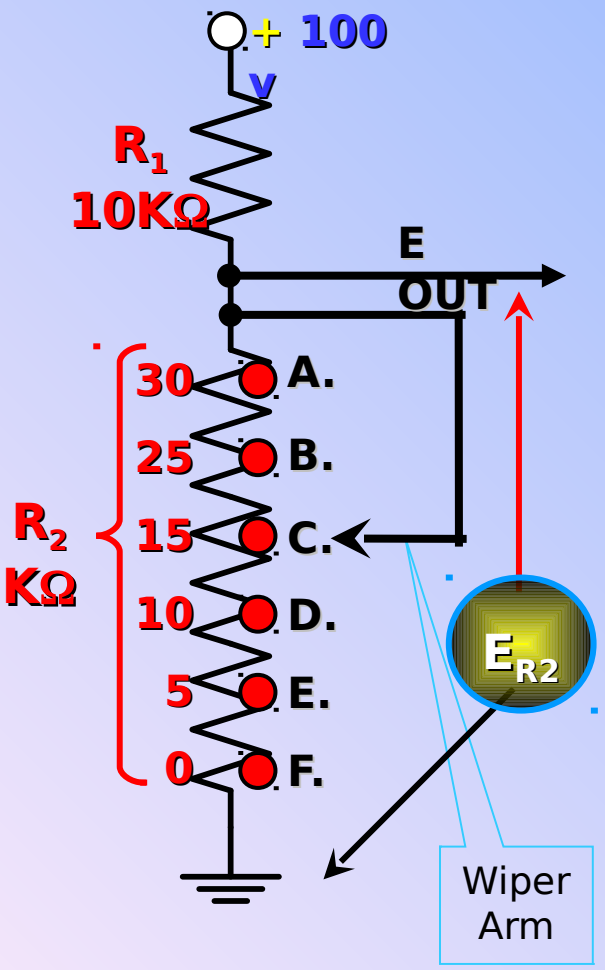
$E_{TP6}$ = - 100 v

**Note: The Voltage @ TP is the SUM of The Voltage Drops From Gnd To the TP being measured, or the Sum of the Voltage Drops between the leads.**

Rheostat

# DC: Voltage Divider

**Rheostat: A Variable Resistor: $R_T$ & $I_T$ changes when the position of the wiper arm is changed.**




**The Wiper Arm Acts as a shorting device.**

**Current takes the path of least resistance, therefore current will take the path of the wiper arm, thus bypassing a portion of the Rheostat $R_2$.**

**$R_T$ Changes w/ the change in position of the Wiper Arm.**

**If $R_T$ changes, $I_T$ will change.**

**@ Position C:** $R_2 = 15\ K\Omega$

$R_T = 25\ K\Omega$

$I_T = 4\ mA$

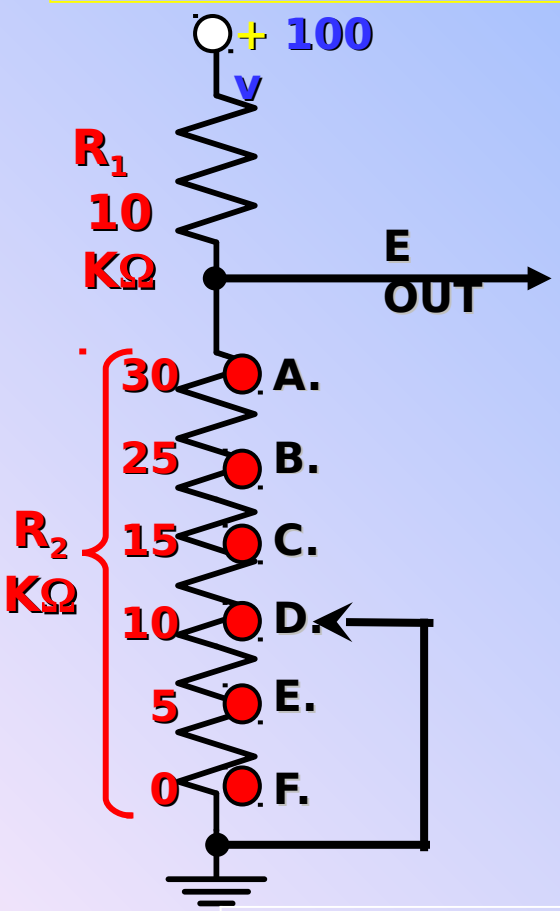
$I_T \times R_2$ **E OUT = 60 v**

Challenge

**E out is the the voltage in reference to Gnd when wiper is @**

# DC: Voltage Divider

**Calculate RT, IT & Output Voltage @ each position, A thru F.**




| @ Position A: | @ Position B: | @ Position C: |
|---|---|---|
| R2 = _____ | R2 = _____ | R2 = _____ |
| RT = _____ | RT = _____ | RT = _____ |
| IT = _____ | IT = _____ | IT = _____ |
| E OUT = ___ | E OUT = ___ | E OUT = ___ |

| @ Position D: | @ Position E: | @ Position F: |
|---|---|---|
| R2 = 20 KΩ | R2 = _____ | R2 = _____ |
| RT = 30 KΩ | RT = _____ | RT = _____ |
| IT = 3.33 mA | IT = _____ | IT = _____ |
| E OUT = 66.6V | E OUT = ___ | E OUT = ___ |

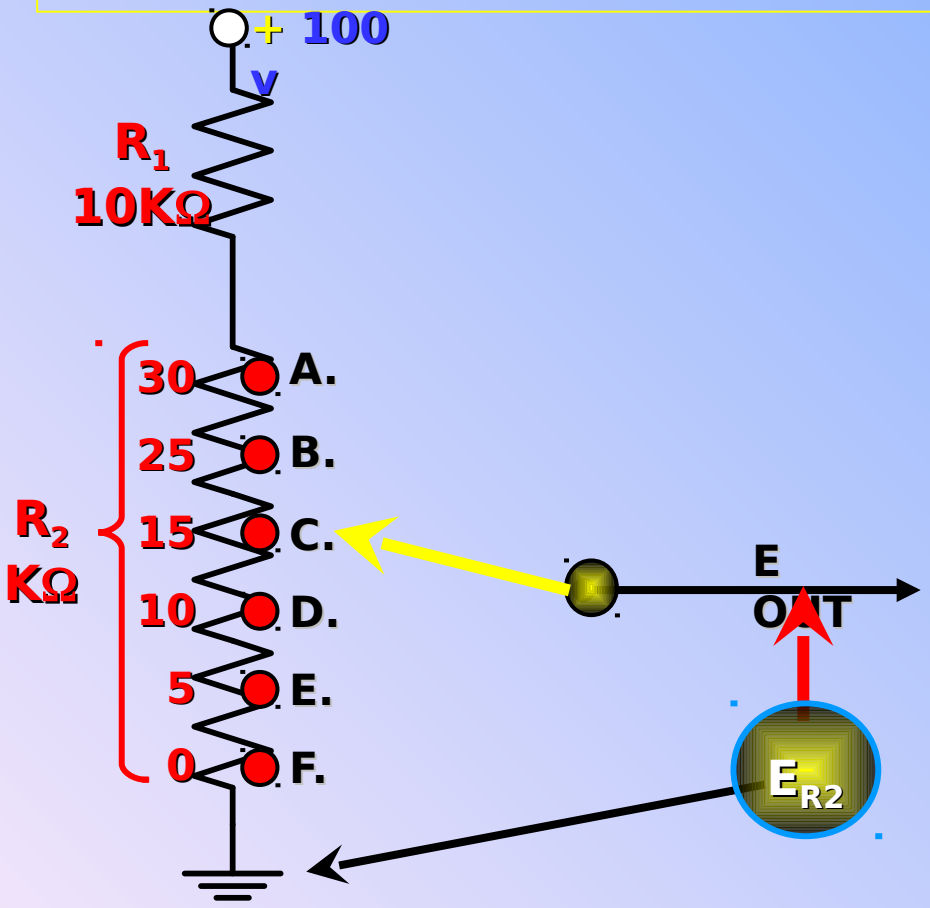
**Note:** { As Drawn}

The position of the wiper is @ ground. Current will bypass 10 KΩ in R2, R2 will equal 20 KΩ.

Answers

# DC: Voltage Divider

**Potentiometer [Pot]: A Variable Resistor: $R_T$ & $I_T$ remain constant.**




$E_A$ = 100v

$R_T$ = 40KΩ

$I_T$ = 2.5 mA

E Out @

A. =

B. =

C. = 37.5 v $I_T$ X [$R_2$ @ C.] =

=

D. =

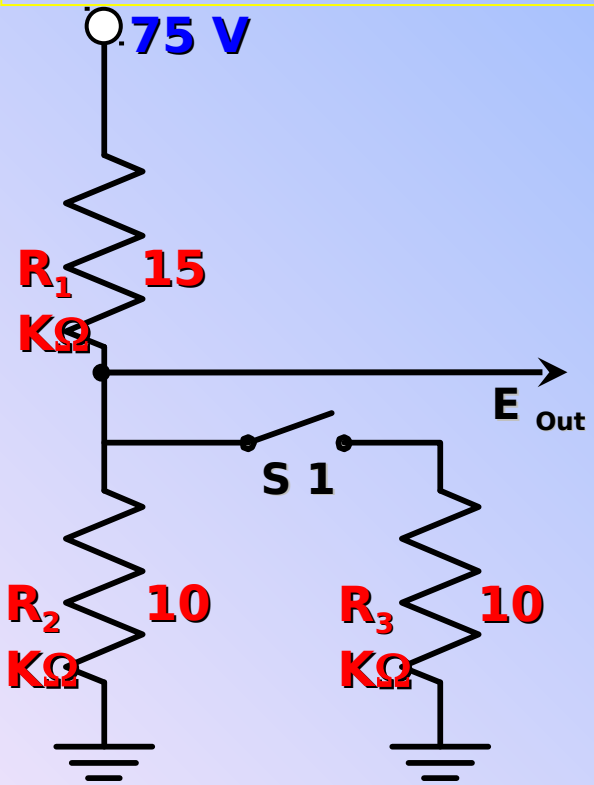
E. =

F. =

Answers

# DC: Voltage Divider

The "Electric Chair": $R_T$, $I_T$ & $E_{Out}$ Changes w/Switch position.




| S1 Open | S1 Closed |
|---|---|
| $R_T$ = | |
| $I_T$ = | |
| $E_{Out}$ = | |

W/S1 Open, $R_1$ & $R_2$ is a Series Ckt.
The Voltage is developed across $R_2$.

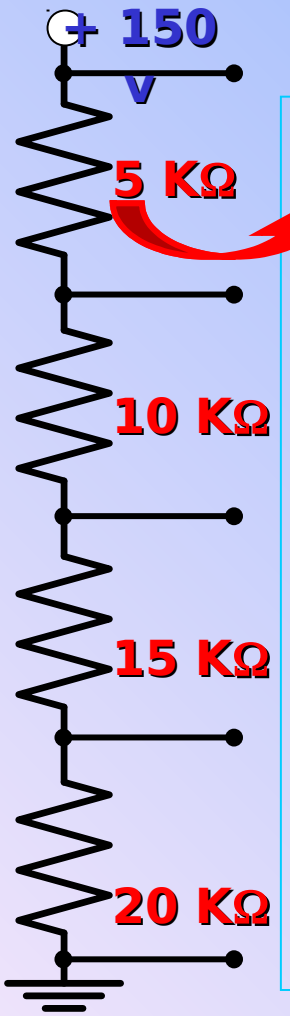
W/S1 Closed, $R_2$ & $R_3$ is a Parallel Ckt, w/$R_1$ Added, the Ckt is Series-Parallel.

The Voltage is developed across $R_2$ & $R_3$ in parallel.

Answers

# DC: Voltage Divider

**Ratio Method : For Voltage Drops in a Voltage Divider.**




$R_T$ = 50 KΩ  EA = 150 v  $I_T$ = 3 mA

5 /50 = 1/10 = .1 X 150 = $E_{R1}$ = 15 v

$E_{R2}$ = ?

$E_{R3}$ =?

$E_{R4}$ = ?

Answers

# DC: Voltage Divider

**Problem Sheets :**

**1. Use the Ratio method, on 1-4, Do not use Ohms Law. [In Reference to Gnd.]**

**Calculate the Output Voltages for *Fig 1.***

**TP2 =_____**

**TP3 =_____**

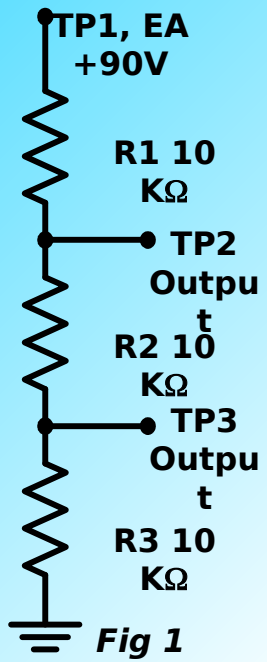



***Fig 1***

**2. Determine by inspection. Are the Output voltages in *Fig 1* different than the output voltages in *Fig 2* ? Yes/No**

**_____**

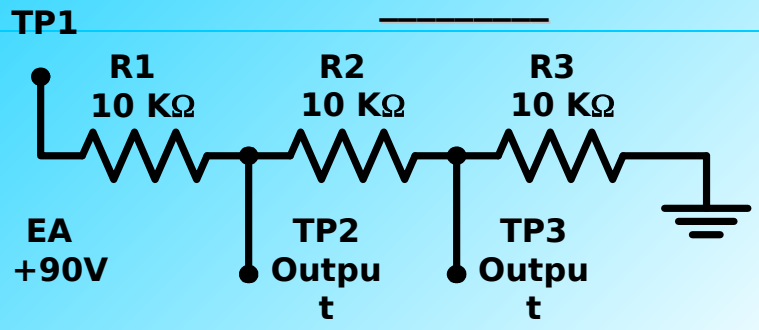



***Fig 2***

Answer 1 & 2

# DC: Voltage Divider

**Problem Sheets :**

**3. Calculate the Output Voltages for *Fig 3.***

**TP2 = _____**

**TP3 = _____**

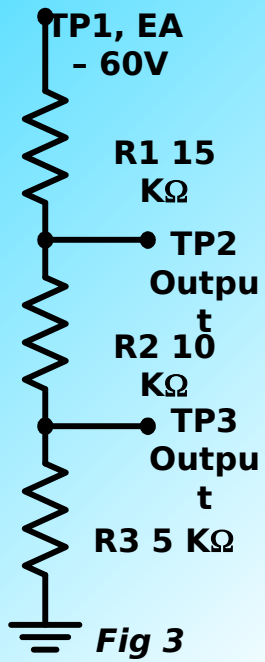



*Fig 3*

**4. Determine by inspection. Are the Output voltages in *Fig 4* different than the output voltages in *Fig 3* ? Yes/No**

**_____**

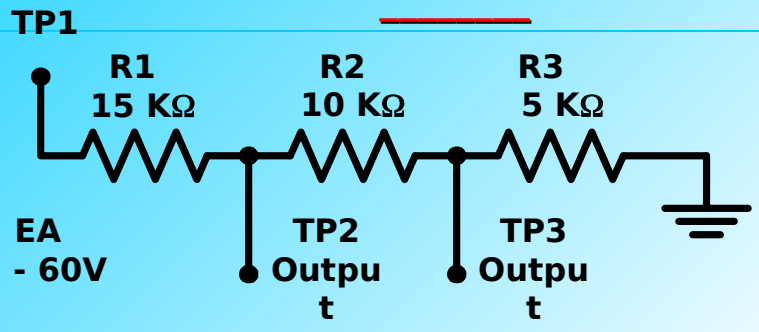



*Fig 4*

Answers 3 & 4

# DC: Voltage Divider

**Problem Sheets :**

**5.** Calculate the Potentiometer Output Voltages when the wiper arm is @ the various points. *Fig 5.*

**Point B** _____

**Point C** _____

**Point D** _____

**Point F** _____

**RT =** _____

**IT =** _____

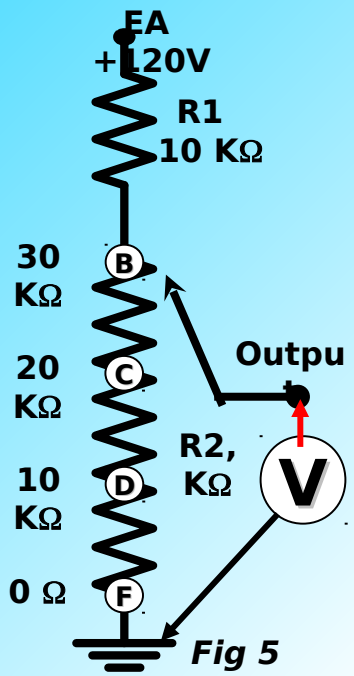



*Fig 5*

**6.** Calculate the output Voltage when the wiper arm is @, **Point A** _____

**Point B** _____

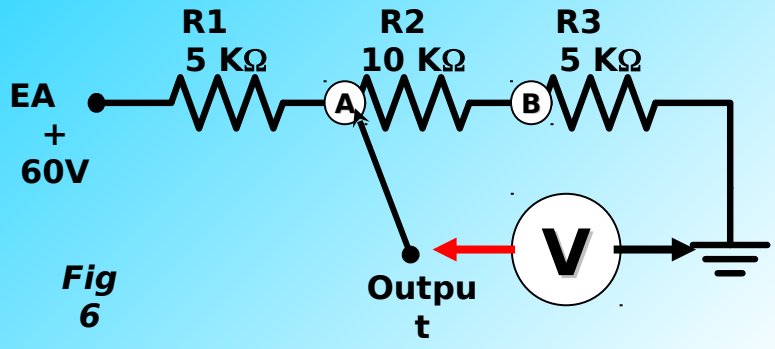



*Fig 6*

Answers 5 & 6

# DC: Voltage Divider

**Problem Sheets :**

**7.** Calculate the Rheostat Output Voltages, RT & IT when the wiper arm is @ the various points. *Fig 7.*

**Point G** _____
**RT** = ____ **IT** = _____

**Point H** _____
**RT** = ____ **IT** = _____

**Point J** _____
**RT** = ____ **IT** = _____

**Point M** _____
**RT** = ____ **IT** = _____

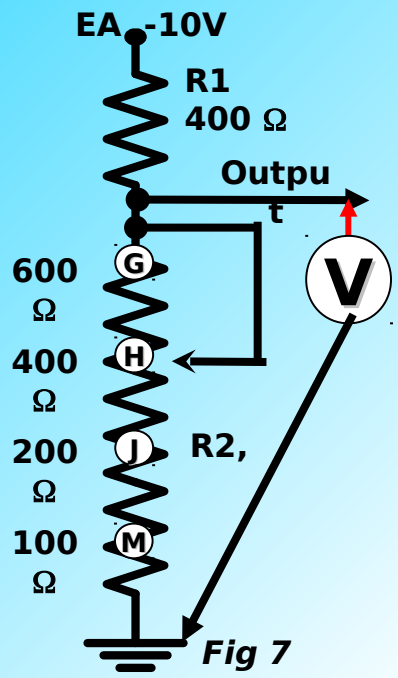


*Fig 7*

**8.** Calculate the output Voltage when the wiper arm is @, **Point A** _____

**Point B** _____

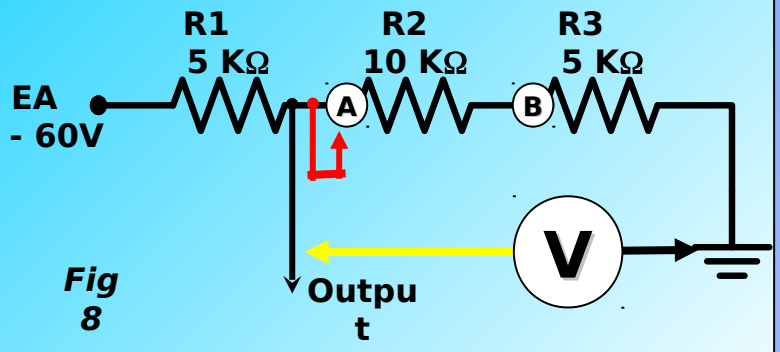


*Fig 8*

Answers 7 & 8

# DC: Voltage Divider

## Problem Sheets :

**NOTE: Reference *Fig 9* for ?s 9-13. All Voltages are in reference to Gnd.**

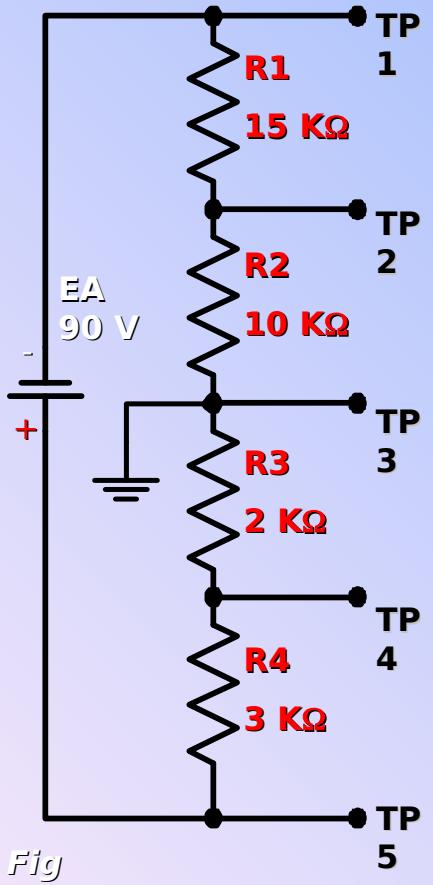



*Fig 9*

9. **What are the normal Ckt values?**

   **EA ____ , RT _____ , IT _____ .**

10. **What polarity & Voltage is measured @ TP4?**

    **_____**

11. **What polarity & Voltage is measured @ TP2?**

    **_____**

12. **What polarity & Voltage is measured @ TP1?**

    **_____**

13. **What are the Voltage Drops for the following?**

    **ER1 ____ , ER2 ____ , ER3 ____ , ER4 ____**

Answers; 9 - 13

# DC: Voltage Divider

## Problem Sheets :

**NOTE: Reference to *Fig 10* for ?s 14-18. All Voltages are in reference to Gnd.**

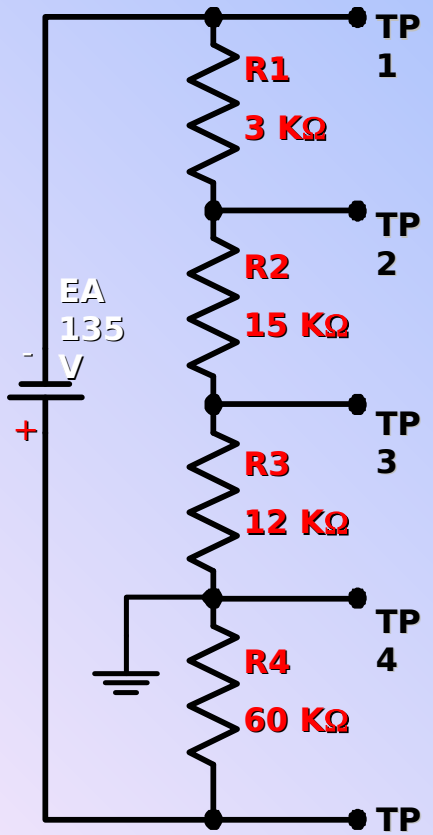



*Fig 10*

14. **What are the normal Ckt values?**

    **EA ____ , RT ____ , IT ____.**

15. **What polarity & Voltage is measured @ TP3?**

    **_____**

16. **What polarity & Voltage is measured @ TP2?**

    **_____**

17. **What polarity & Voltage is measured @ TP5?**

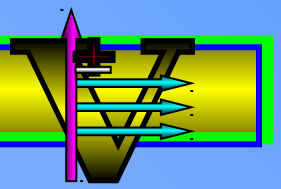
    **_____**

18. **What are the Voltage Drops for the following?**

    **ER1 ____ , ER2 ____ , ER3 ____ , ER4 ____ .**

Answers; 14 -18

# DC: Voltage Divider



**Lesson Test:**

**Standard:** 10 Questions, W/in 20 minutes

70% Minimum Accuracy.

80% for EOD

**References:** Official OMMCS Training Aids.